PRESENT STRAINS IN THE RELATIONS BETWEEN SCIENCE, TECHNOLOGY AND SOCIETY*

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I

During the last twenty years and at almost every level of Western culture, signs of profound strain have appeared in the relation of science and technology to society. Sometimes this strain has taken the form of aggressive assertions of the superiority of feeling and intuition over logic and reason. In the climactic scene of the movie "Star Wars," for example, the hero deliberately turns off the computer-controlled system guiding his rocket and trusts his feelings to guide his bombing run on the enemy warship. In an extremely popular series of books, Carlos Castaneda offered an ostensibly documentary account of a social science graduate student's "de-programming" from his rationalistic and scientific mind-conditioning by a Yaqui Indian sorcerer, who showed him the world as it "really" was and as it could not be seen by Western science. In The Tao of Physics, physicist Fritjof Capra argued that the apparent anti-intellectualism of Eastern mystical religious philosophy in fact embodied a trans-logical approach to reality that is validated by quantum mechanics and quantum field theory. In Against Method, philosopher of science Paul K. Feyerabend denied that scientific thinking could, on available evidence, be shown to be constrained by a rational or logical methodology (e.g., the Baconian method). He called for an explicitly anarchic/Dadaist epistemology that would liberate students of science from the enervating myth of learning to reason methodically from empirical data to theoretical constructions.

Other signs of strain abound. A host of books that are critical (and, in the main, destructively so) of technology have received widespread acclaim since the late 1950's.[1] There have emerged, even within the scientific community itself, condemnations of certain lines of scientific inquiry as a priori unscientific or simply forbidden, and calls for moratoria on research in certain areas. Not only have astrology, magic, and spiritism maintained their strength among traditional supporters, but their popularity has spread, marked by intense interest on the part of scientists in parapsychology, mysticism, and the speculations of Velikovsky, von Däniken and others Also relevant to this strain are the world-wide revival of religious fundamentalism and messianism and the proliferation of anti-rational authoritarian

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cults. Finally, the power of the consumer movement, the anti-nuclear movement and allied environmentalists, and the many supporters of zero-growth economics, all add to a sense of the pervasiveness of current criticism of the social roles of science and technology.

How may we account for the appearance of these tensions in a society that, as recently as the early 1960's, seemed to accept science as the locus of what we could know about the world and accept technology as the vehicle for applying that knowledge to the advancement of human well-being?

It is tempting to blame developments within science and technology for these strains, and to claim that, by recent products and institutional affiliations, science and technology have revealed themselves to be unworthy of public trust and hope. Three particular indictments are presumed to indicate the moral bankruptcy of science and technology: indifference to the environmental impact of production (including the impact on people involved in production); participation in the development of fearsome armaments; and reinforcement of rampant consumerism. But this initially plausible account will not satisfactorily explain the appearance of these tensions during the last twenty years. No significant value judgments appear in the current critical literature that cannot be found in 19th and early 20th century literature, long before the allegedly "causal" internal developments occurred. In short, the salient points of current criticism have long been articulated forcefully and well, in particular during the course of the 19th century. Yet these earlier articulations did not provoke the broad public response that characterizes the current debate. It is thus appropriate to look, not at science and technology themselves, but at the cultural value context within which they are pursued, in order to discern what makes our culture responsive now to what it ignored before.

II

The most common theme of contemporary critics of science is that it is wrong to identify human well-being with technical, or even conceptual, sophistication, i.e., that it is wrong to see progress in knowledge of nature or in technology as privileged indices of human progress. Personally, I would agree with this claim, but it is hardly new. The early Hebrew prophets--for example, Isaiah--warned against the identification of personal well-being (the well-being that eventuates in salvation) with the work of one's hands, without thereby denying the superiority of comfort, health and prosperity to discomfort, illness and poverty, if righteousness is held constant. Certainly Socrates explicitly addressed this question when he criticized Anaxagoras for being concerned with the nature of the Sun (jeopardizing his life in the process) while still ignorant of his own nature as a person. Plato and Aristotle, from different directions to be sure, dealt at length with the error (to them) of supposing that technical mastery over nature, or scientific knowledge was a measure of truly human fulfillment. For Plato, a human being's proper "home" was in a supra-natural realm and any excellence in the realm of the natural was bound to be a potent seductive force luring the soul away from that home. For Aristotle, a human's highest act was abstract and purposeless thinking (i.e., thinking about thinking), emulating the fully-actual being that undergirds Aristotle's ontology. Technical mastery and even

theoretical understanding of nature were merely steps on the way to the truly valuable states of mind that constituted fulfillment of the human condition. A vast literature from Hellenistic, Roman, Medieval, and Renaissance times (also from Islam, India, and China) links these ancient criticisms of science and technology as irrelevant to human advancement with analogous criticisms made during the Industrial Revolution.

In the 18th century, for example, three very different writers made penetrating analyses of the fast-maturing science and technology of their "modern" age. In Gulliver's Travels, Jonathan Swift relentlessly parodied the scientific researcher who begs support for his studies from everyone within earshot, promising vast social benefits from projects that are clearly personal obsessions and (equally clearly) hopelessly misconceived and manifestly sterile. In Émile, Jean-Jacques Rousseau argued that technology was a major obstacle to the realization of human well-being, alienating humanity from the Nature within which human nature necessarily unfolded. In his epic re-creation of the Faust legend, Goethe created a hero whose passion to comprehend the fabric of reality led him to compromise his most elementary values and jeopardise his immortal soul. Faust longed "to detect the inmost force, that binds the world and guides its course, all germs and forces to explore" and so "the bitter task forego of saying the things I do not know." As had Swift, Goethe sensed the personal passion behind the profession of social benefit that underlay science and technology.

At the height of the first Industrial Revolution, side by side with the myriad tracts that extolled the power of machinery to eliminate negatives in the human condition and promised to convert earth into heaven and people into something approaching angels, there were also cogent arguments that all these promises were based on erroneous interpretations of human nature and its relationship with external nature. Henry David Thoreau, for example, gave particularly acute expression to one problematic feature of technology in his review (1843) of The Paradise Within Reach of All Men, Without Labor, by Powers of Nature and Machinery. Thoreau contrasted the attitudes of the ethical philosopher (that is, the philosopher of ethics) and the mechanical philosopher toward humanity's relation to nature. The former believed that if "he will reform himself. . . .then nature and circumstances will be right," while the latter believed that if one can "reform nature and circumstances. . . .then Man will be right." Until recently, Western society adopted the mechanician's approach and rejected the ethician's. Now the question of which approach is correct, or of what balance between the two is most valuable, has again come up for discussion. Characteristically, today's discussion is not placed in an historical context that exposes how central perennial value judgments are to choosing between these approaches. Rather, the discussion treats the choice of approach as a consequence of the unique current state of affairs.

Shortly after Thoreau's review appeared, Robert Dale Owen, son of the utopian English socialist-industrialist reformer Robert Owen and heir to his father's ideals, called attention to another puzzling feature of the exploitation of technology: "Mechanical improvements, inevitable even if they were mischievous, and in themselves a rich blessing as sure as they are inevitable--are becoming by some strange perversion of their use, a cruel and deadly curse." Owen wrote this in 1848. Half a dozen years later,

the United States government could no longer avoid legislation regulating the manufacture and operation of steam engines. In London in 1855, a public scandal followed a physician's exposé of the use of harmful additives by commercial food processors. Concurrently, devastation of large sections of the English countryside by air pollution from manufactories (for example, in the Midlands) soon forced passage of the Alkali Works Regulation Act (1864). A contemporary account in the journal Chemical News noted that regulatory legislation was inevitable because, without it, toxic pollutants were apparently controlled only where public outcry was intense. Manufacturers claimed that they could not meet the mandated control standards and that regulation would threaten the general prosperity; these claims, the journal noted, were, in fact, proving groundless. In the United States, also in the 1860's, there were warnings that industrial pollution along the Schuylkill River threatened Philadelphia's domestic water supply. Thirty years of municipal controversy ensued, ending without any attempt to control the polluters, but with a plan for building the best filtration plant technology could provide, thereby evading the political challenge of writing and enforcing pollution-control legislation. As in the Midlands, Philadelphia manufacturers argued that they were the basis of the area's prosperity, and that harassment could undermine this prosperity, resulting in much poorer people who would have much cleaner water to drink.

In The Coal Question (1865), the English physicist Stanley Jevons addressed still another problem confronting a society whose prosperity was based on high-level technology. Jevons argued, with uncommon attention to statistical data, that England's coal-based high-technology economy would, in spite of apparently enormous coal reserves, soon be strained to the point at which England could no longer favorably compete with foreign manufacturers. People had been misled into thinking that England's coal supply was inexhaustible. They were paying no attention to the rate of increase in coal consumption and to increased costs of obtaining that coal from ever deeper mines. Jevons further argued that the recent adoption of petroleum as a fuel would not materially affect his conclusions because it, too, was only a finite resource and because England would have to compete for it with other nations, thereby losing the cost advantage conferred by burning domestic coal. England, he concluded, could expect to sustain prosperity based on high-technology for no more than 200 years, and perhaps considerably less, even if petroleum turned out to be a major fuel in the future. Jevons attempted to sketch both the style of social life that would stretch the coal supply and the type that would result if the supply were rapidly depleted. Both scenarios removed England from a position of influence in world affairs. The nation, Jevons argued, had to choose "between brief greatness and longer continued mediocrity." There was, he thought, a good deal to be said for brief greatness, not merely as an expression of English vanity, but for its value to all the world. "No part, no function of a nation is independent of the rest, and in fearlessly following our instincts of rapid growth we may rear a fabric of varied civilization, we may develop talents and virtues, and propagate influence which could not have resulted from slow, restricted growth, however prolonged." A governmental commission of inquiry, convened in the wake of critical response to Jevons' book, concluded that his predictions were unduly pessimistic, that all was well, and that nothing need then be done or feared.

By the end of the 19th century, scores of World's Fairs, national and international industrial and scientific exhibitions, expositions and congresses had trumpeted the imminence of earthly salvation evident in these manifest triumphs of society. Henry Adams, in his essay "The Dynamo and the Virgin," reflected on his visit to the Paris Industrial Exposition of 1900, accompanied by the American physicist Samuel Pierpont Langley. Adams had stood dumb-struck before the electric dynamos. Although Langley characterized them as merely "ingenious channels for conveying somewhere" the energy latent in coal, Adams, who was almost totally ignorant of natural science, demurred. For Adams, the dynamo was a clear "symbol of infinity," a "moral force," "the most expressive symbol of ultimate energy." The dynamo reminded him of the Virgin Mary and caused him to reflect upon how hopelessly shallow were American notions of symbols. In the Middle Ages, he wrote, the Virgin was by no means a passive symbol of faith. She was a moving force, the dynamo of that time, one that had powered the construction of all of the great Gothic cathedrals, in consequence dedicated to her. Adams was convinced that the technological dynamo was a similar force that would generate characteristic constructions in the new 20th century. What would those constructions be? Adams did not know, but his tone was distinctly pessimistic.

After describing recent developments in atomic physics and the possibility they could result in explosives that would dwarf TNT, English physicist Frederick Soddy, home on leave from the "war to end all wars," asked his audience to "imagine. . .what the present war would be like if such an [atomic] explosive had actually been discovered instead of being still in the keeping of the future." Its discovery "conceivably might be made tomorrow, in time for its development and perfection for the use or destruction, let us say, of the next generation, and which it is pretty certain, will be made by science sooner or later." From the side of science and technology in other words, the development of atomic energy was virtually inevitable in Soddy's opinion. The question that was still open in 1915 was whether it would be for the use or for the destruction of the generation that would play host to that development.

III

The political and intellectual antagonisms to science and technology that reappeared in the 1960's and 1970's were not based on abstract moral and philosophical principles as ancient and classical criticisms were, but were tied directly to existential problems already being posed by the new technology: large-scale unemployment, noise, air and water pollution, harm to and alienation of workers, disruption of harmonious relationships among small units of people or between people and nature, and so forth.

What underlies the spread today of attitudes that did not spread earlier? Note the new thrust of this question. It is no longer a matter of accounting for a current discovery that science and technology are problematic. Rather, we need to understand how acquiescence in age-old perceptions of their problematicity is symptomatic of a broader, much more fundamental value shift in our culture, one with which the values embedded in science and technology are no longer concordant. I would like to point briefly to three cultural phenomena that may illuminate the value shift which has,

for many, isolated science and technology from questions of human development.

(1) Identifying progress in science and technology with human progress is clearly part of the rhetoric of the idea of progress itself. As long as there was widespread public conviction that human progress was not only possible but was in fact taking place, then the manifest advances of science and technology could naturally be taken as authentic indicators of human progress. We now know that those who, in the 16th and 17th centuries, defended the reality of progress in the popular public debates of the time were ultimately acknowledged right and those who denied progress, wrong. Francis Bacon, for one, rode to fame as "father" of modern science on the back of the progressivist faction, largely Puritan. The Puritans, partly because of messianic convictions, were strong progressivists who reformed the English educational system to reflect this, initiating a chain of events not unrelated to the founding of the Royal Society.[2] Today, the idea of human progress is itself up for revaluation. In its train, it draws down for revaluation the human implications of advance in science and technology. It has suddenly become commonplace to deny that significant progress in being human has taken place during recorded history, and much criticism of science and technology is directed precisely to this end. Nothing essentially human, it is claimed, advances through acquisition of technique or the elaboration of enormously complex and abstract (that is, removed from common experience) theories that supposedly demonstrate that we "understand" the world in which we find ourselves. Thus there is a turning from knowledge, pursued in universities, laboratories, and books (pursued, that is, in the heart of "advanced" civilization), to wisdom, sought from sages, gurus and saints living primitively, in both a conceptual and technological sense. When one denies that truly human progress has occurred in the course of Western cultural development, two conclusions relevant to science and technology seem to follow: advances internal to science and technology are no longer taken as authentic indicators of human progress; rather, these advances suddenly become interpretable as potent seductive forces, to be forcefully opposed, as Plato had already foreseen.

(2) One feature of recent Western intellectual history has profoundly reinforced the preceding line of thought, namely, the undermining of classical notions of objectivity and rationalism, beginning with the formulation of non-Euclidean geometries in the mid-19th century. The central implication of non-Euclidean geometries for the rationalism that had dominated Western intellectual history ever since classical antiquity was its severing of any necessary connection between logic and ontology. From Pythagoras and Parmenides to Hegel, it was axiomatic for all but a handful of philosophers that there was the most profound connection between thought and reality, a connection that was secured in the case of syllogistic thought and exemplified in the theorems of Euclid's Elements. That alternative (and exclusive) axiomatisations of geometry are possible, makes it impossible to proclaim confidently that deductive inferences even from true premises are truths about reality independent of the human mind. In short, ontological inferences can no longer be based solely on logically necessary reasoning, as was the case, for example, with Descartes, Spinoza and Leibniz.

It is unfortunate that the development of non-Euclidean geometries is so often taken to be a development internal to the historical development of mathematics and is not appreciated as a fundamental development within Western culture. Coordinate with this revolutionary undermining of rationality in mathematics was an added and complementary undermining of the objectivity of mathematical modelling in the sciences, so that by the late 19th century it was possible, and even common, to claim that scientific theories were in some essential measure arbitrary constructs of the human mind and not simply revelations of the structure of the external world.[3]

I have elsewhere[4] argued that, at least since the mid-19th century, Western literature, art and music have increasingly reflected a rejection of the claim that objectivity and canonical rationality are privileged routes to truth. Henri Bergson began a systematic philosophical defense of this rejection in the late 19th century, one that was destined to become an intellectual analogue of activities in symbolist poetry, stream of consciousness novels, atonal music, and post-Impressionist art. The "sudden" passion today for parapsychology, mysticism, intuition, Eastern philosophy, "other states" of mind, fundamentalist religions and rejection of the products of science and technology as indices of human achievement is less startling, less "sudden," when viewed against the horizon of these cultural phenomena.

(3) The emergence of medical ethics as an area of intense public interest and as a new scholarly discipline reveals something of the roots of current criticism of science and technology. In medical ethics, we often find the facile claim that medical technology is the root of a new crisis in health care, and that medical science has nothing positive to contribute to its resolution. To me, however, this "crisis" is not at all new and only reveals that medical technology has made it impossible for people to continue to avoid perennial value questions central to human existence, value questions which the masses of humanity have "successfully" avoided for all of recorded history: for example, what is life; what is death; when is life; when is death; what is the nature of authentically human existence; what is health; what are the relative obligations and rights of patients, physicians, societies? No current medical-ethical issue of significance is truly a consequence of current technology. These issues are, however, forced upon our attention by medical technology and in the process we must acknowledge that, the persistent cries of physicians, philosophers and theologians notwithstanding, we have chosen for millennia to ignore these questions, largely for lack of any practical choice in the matter. As medical science and technology continue to present new choices, we are unable to choose and so lash out at the "moral bankruptcy" of the science and technology that we feel placed us in this position.

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The current literature critical of science and technology emphasizes the capability of science and technology for generating social problems that we are at a loss to resolve. It seems, however, far more correct to say that the increased leisure, prosperity, freedom, and power provided by science and technology are now forcing us to grapple with perennial value

questions that a meaner existence had relegated to the province of abstraction. A generic feature of human nature that emerges from consideration of the three phenomena discussed above is our unwillingness to confront value questions unless confrontation is forced upon us by concrete contexts of experience. The sudden popularity of medical ethics exemplifies this especially well. Thus, an informed awareness that science and technology raise profound personal and social value questions has existed for at least 2500 years, yet contemporary critics insist upon channelling the responsibility for the anxiety generated by these questions onto specific theories and machines. That is, they insist upon placing the responsibility on external features of the human environment instead of seeing this anxiety as a projection of an internal feature of that environment, one to which psychology and sociology are as relevant as political action.

NOTES

1. Let me just name what seems to me to be a representative selection of the more prominent books that I have in mind: John Kenneth Galbraith's The Affluent Society, Rachel Carson's Silent Spring, Ralph Nader's Unsafe At Any Speed, Vance Packard's The Hidden Persuaders, C.P. Snow's The Two Cultures, Jacques Ellul's The Technological Society, Alvin Toffler's Future Shock, Theodore Rozsak's The Making of a Counter-culture, Charles Reich's The Greening of America, René Dubos' So Human An Animal, Dennis Meadows' The Limits To Growth, E.F. Schumacher's Small Is Beautiful, Lewis Mumford's Pentagon of Power, Joseph Weizenbaum's Computer Power and Human Reason, Ivan Illich's Medical Nemesis. To be sure, these books differ wildly from one another, in tone, in the sense that they make, and in what they claim, but all are profoundly critical of the functioning of contemporary technology.

2. Comenius, the great Czech thinker whose Moravian Church had much in common with the Puritans and who was consulted by them, warned that if the new philosophy of nature did not consider the ends to which knowledge was to be put as legitimately within its purview, then such an organization as the Royal Society was as likely to lead to a Babylon on Earth as to a Heaven.

3. Prominent representatives of this interpretation of science in the 19th century include William Whewell, Auguste Comte, Claude Bernard, Ernst Mach, Heinrich Hertz (see the introduction to his Principles of Mechanics), Pierre Duhem, Henri Poincaré and Émile Meyerson. More recently, this view has been developed dramatically by Jean Piaget and argued by Thomas Kuhn, Michael Polanyi, Norwood Hanson and Paul Feyerbend.

4. S.L. Goldman, "The Metaphysics of Objective Reason," 1 Science/Technology and the Humanities 3 (Fall 1978).